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DIETOTHERAPY IN HYPERTENSION

By RUTH WOODS

One of the major concerns of the science of dietetics has been the development for therapeutic purposes of special diets for use in the treatment of various metabolic and degenerative diseases. Many of these diets have been developed solely on empirical grounds. A large majority have withstood the test of continued usage through the years. In recent times, advances in physiology, biochemistry and nutrition have served to explain a significant part of the rationale behind the use of many such therapeutic diets. Thus, for example, the scientific principles behind the use of the special diets used in diabetes, gout, liver dysfunction, to cite a few, are now more or less well established. In the case of other diseases, however, the mechanisms underlying the therapeutic action of certain diets remains nebulous, although clinical experience appears to substantiate the efficacy of these diets as important adjuncts in the treatment of disease.

The use of special diets as a supplement to drug therapy in the treatment of hypertension and related disorders is a typical example of how disease may be controlled in part by dietetic means, although the scientific explanation in this instance is still largely a matter of conjecture. Most prominent among the special diets in use today for the control of hypertension is the so-called "rice-fruit" diet. Although dramatic therapeutic successes have been reported as a result of the use of this diet, bitter controversy still exists as to its real merit. The present paper will attempt to review the basic diets recommended for the treatment of hypertension, with particular reference to the "rice-fruit" diet and the possible rationale behind its use.

Early Background:

A description of abnormally high blood pressure as a specific disease entity was first given by von Basch (1) in Germany in 1874. Some thirty years later, Ambard and Beaujard (2) in France suggested that restriction of the sodium chloride (salt) content of the diet had a marked effect in the treatment of this disease. This concept was repeated a few years later by the German physician, Volhard (3). These early suggestions were the first intimations that hypertension might be controlled by dietary means in addition to the use of special drugs, rest, sedatives, psychotherapy and other measures, both old and new. The principle of sodium chloride restriction was first adopted in this country by Allen and Sherrill (4) in 1920 and has since had many supporters. Although the mechanism underlying the

action of salt restriction, or more specifically of any source of sodium or chlorine ions, is still somewhat obscure, this procedure is still in favor among many investigators today. There is nevertheless considerable controversy at present as to the real merit of severe sodium chloride restriction and it may be that only after many more controlled clinical studies can this question be satisfactorily resolved.

As the relation of diet to hypertension received further attention, the concept of severe caloric restriction as a therapeutic measure began to emerge as another principle in the dietary management of this disease (5). In the opinion of many modern clinicians, drastic food restriction accompanied by marked weight loss is considered to be of major significance in the control of hypertension regardless of the sodium intake (6, 7, 8). The possibility also remains that a combination of both calorie and sodium restriction may be the deciding factor in the dietary control of high blood pressure.

The Rice Diet:

In recent years, interest in the dietary management of hypertension has been tremendously stimulated by the work of Kempner (9, 10) who has reported dramatic, and often almost incredible, successes resulting from a special therapeutic diet popularly referred to as the "rice diet."

Nature and Effect of the Rice Diet: The rice diet is a severely restricted diet low in both calories and sodium chloride, as well as in protein and fat. It consists exclusively of from 250 to 350 grams dry weight of rice daily, cooked only with plain water or fruit juice, together with fruit, fruit juice (700 to 1000 ml. per day), and white sugar or dextrose in quantities of from 100 to 500 grams. Dried fruits, dates, nuts and avocadoes are not permitted among the dietary fruits because of their sodium chloride content. The diet has been calculated to provide about 2000 calories per day, 5 grams of fat, about 20 grams of protein, 450 grams of carbohydrate and not more than 0.15 gram of sodium and 0.2 gram of chloride. The diet is supplemented with vitamins and minerals in the following amounts:

Vitamin A	5000 I.U.	Niacinamide	25 mg.
Vitamin D	1000 I.U.	Calcium pantothenate	2 mg.
Thiamine	5 mg.	Iron (ferrous sulfate)	0.6 gram
Riboflavin	5 mg.		

The diet was first instituted in 1940 by Kempner at the Duke University School of Medicine. In 1944 two published reports appeared (9, 10) describing the results of treatment of some 150 patients during this period by means

of the rice diet. The disadvantages of the diet were frankly described by Kempner who said:

> "It is a greater pleasure to talk for fifteen minutes about the treatment of kidney disease and hypertensive vascular disease with the rice diet than to eat this diet three times daily for fifteen days or for fifteen weeks or for fifteen months. Let me start with a number of unpleasant facts: (1) This is a monotonous diet and it does not taste good. . . . (2) One has to eat it quite a while before its full effect becomes apparent. (3) The patients should be in the hospital until they are 'regulated' on the diet and constant checks on their blood and urine chemistry should be made. (4) The diet becomes worthless if it is modified by so-called 'small' or 'minimal' additions according to the patient's own taste."

Despite this discouraging picture, Kempner concluded:

> "There is only one excuse for such a therapy: It helps. And if there is a choice between an unpleasant diet on the one side and cardiac failure, uremia, encephalopathy or blindness on the other side, I think the diet is the lesser evil."

Following a four year investigation of the therapeutic value of this diet, Kempner established that it exerted pronounced beneficial effects not only in hypertension, but in certain forms of acute and chronic kidney disease.* The periods of treatment varied from four days to thirty months, no harmful effects having been observed in any of the subjects. Of the 150 patients treated, 109 or 73 per cent were benefited. The positive results of treatment included marked drop of blood pressure, reduction to normal size of enlarged heart, improvement in electrocardiogram readings, reduction of edema, and healing of retinal hemorrhages due to excessive blood pressure in the retina with consequent restoration of sight in cases of blindness.

Protein Balance On the Rice Diet:

Further studies on the biochemical effects of the rice diet were reported the following year (11, 12). Although the daily protein intake on this diet is extremely low, 20 grams (average recommended daily allowance for adults being 70 grams), no reduction in plasma protein levels or in hemoglobin was found. Very little nitrogen was excreted in the urine. Calculating a total daily loss of 3.16 grams of nitrogen, it was pointed out that a daily nitrogen intake of 3.2 g. x 6.25,** equivalent to 20 g. of protein, was sufficient to maintain these patients in protein equilibrium.

A number of investigators have challenged the fact that an intake of 20 grams is sufficient to maintain protein balance. The calculations used

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*Chronic kidney disease is often a major contributing factor in the development of the associated symptom of high blood pressure.

**An arbitrary constant used for the conversion of nitrogen into its protein equivalent.

by Kempner, for example, presuppose complete and efficient utilization of dietary protein—which may not actually be so.

Actual nitrogen balance studies on the Kempner rice diet were carried out by Schwartz and Merlis (13) in a study reported only a few months ago. Their subjects included six physically normal adults and only one hypertensive patient, a fact which may have altered the findings. According to actual chemical determination of the diet, they found the daily nitrogen intake to be 2.63 grams (equivalent to 16.43 g. protein) rather than 3.28 grams (20 g. protein) as estimated by Kempner from tables of food values. Further, while Kempner calculated all of his patients to be in nitrogen balance, Schwartz and Merlis found all of their subjects to be in negative balance, averaging a loss of about 3.2 g. of nitrogen per day. The nitrogen loss in their hypertensive subject was somewhat less than that of the normal subjects. On the basis of these findings, Schwartz and Merlis conclude that it is impossible to maintain nitrogen equilibrium on the rice diet. They do point out, however, that:

> "It is worthy of note that the hypertensive patient showed a marked clinical improvement on the Kempner regime although he failed to maintain nitrogen equilibrium. During the diet therapy there was a significant drop in blood pressure and return to upright of T-waves in the electrocardiogram. No fresh retinal hemorrhages occurred and there was dramatic symptomatic relief of headaches, dizziness and malaise."

Whatever the true situation may be, if there is no fall in plasma proteins or hemoglobin as claimed by Kempner, there would seem to be no imminent danger of protein depletion. King (13a) recently suggested that a safe procedure might be to follow the restricted diet for a specific critical period, then to modify it with essential nutritional supplements and, when necessary, return to it for limited periods as a temporary, therapeutic expedient.

Modification of the Rice Diet: Kempner himself has suggested the possibility of modifying the strict rice diet after a suitable period with small additions of other foods (such as non-leguminous vegetables and about two eggs and four ounces of lean meat a week). It has been cautioned, however, that even such slight modifications change the character of the diet and may disturb the entire effect. Where a critical condition of the kidney, heart or retina exists any compromise may prove to be too much and the patient may have to pay for the few exceptions with the reappearance of all the signs and symptoms of the disease. In such cases, it is advised that the strict diet be continued indefinitely just as liver is continued in pernicious anemia and insulin in diabetes.

The Sodium Restricted Diet:

During the course of studies on the effect of low sodium diets in experimental animals, Grollman and Harrison (14) observed such striking reductions in the blood pressure of rats on an exclusive rice diet that they extended their studies to clinical trial with human patients. A preliminary report of their findings (15) was published in 1945.

The diet used was drastically restricted in sodium, containing less than one gram of salt in 2000 calories per day. The diet was considerably more varied than the original rigid rice-fruit-sugar diet of Kempner, however, the low salt content being made possible by the choice of foods naturally low in salt and by the use of dialyzed milk (milk treated to remove the sodium chloride). (Table 1). Palatability of the diet was improved by compensating for salt with seasonings such as pepper, garlic, lemon juice and vanilla.

This diet was used on six patients. One exhibited no response, two showed a reduction of blood pressure to normal levels, and three, only a moderate drop in blood pressure. One of the latter three, however, developed sudden symptoms of collapse, necessitating treatment with sodium chloride injections. Because drastic salt restriction produced striking declines in blood pressure in some of the subjects, the authors suggest this means of dietary control be tried briefly in patients with hypertension and, in those certain cases where the response is favorable, the diet be continued indefinitely.

Failure of Salt Restriction: Although favorable results with salt restriction were reported by very early investigators (2, 3, 4), other workers during the 1920's (16, 17, 18) failed to obtain any demonstrable effects of this type of diet on the course of hypertension. These failures have been attributed by Grollman *et al* (15) to the fact that the restriction of salt in these diets was probably moderate, rather than drastic. They further postulate that the effectiveness of the original rice diet is due largely to its severe restriction of salt.

In a recent medical editorial (18a) on the treatment of hypertension, it has been pointed out that persons who have been on the usual American diet which contains 5 to 8 gm. of sodium (12 to 20 gm. of salt) must follow the low salt regimen for weeks before its effect on blood pressure can be evaluated. Further, the daily intake of sodium must be under 200 mg., because persons who do not sweat freely lose only 300 to 500 mg. of sodium per day from their bodies when salt intake is reduced. For this reason results

Table 1. Typical Menus for the Week* — Low Sodium Diet (15)

Breakfast	Gm.	Lunch	Gm.	Supper	Gm.
MONDAY					
Orange (juice)	50	Meat patties	50	Chicken	50
Grapefruit (juice)	200	Macaroni	125	Peaches	50
1 egg + 1 egg yolk		Tomatoes	75	Grapes	100
Oatmeal	90	Lettuce	25	Apricots	200
Dialyzed milk		Apple	100	Lemon juice	50
Sugar	35	Grape juice	100	Sugar	25
Coffee	as desired	Butter	10	Butter	10
TUESDAY					
Grape juice	200	Lamb	50	Beef patties	50
1 egg + 1 egg yolk		Rice	125	Potatoes	125
Farina	90	Tomatoes	75	Squash	100
Dialyzed milk		Lettuce	25	Butter	10
Sugar	35	Butter	10	Apples	100
Coffee	as desired	Peaches	100	Lemon juice	50
		Orange (juice)	200	Sugar	25
WEDNESDAY					
Grapefruit (juice)	200	Butter	12	Lean steak	50
1 egg + 1 yolk		Beef	60	Squash	100
Rice	120	Eggplant	100	Grapefruit (juice)	66
Dialyzed milk		Macaroni	120	Apples	100
Sugar	38	Apricots	100	Lemon juice	50
Coffee	as desired	Grape juice	100	Sugar	39
		Sugar	20	Butter	12
THURSDAY					
Orange (juice)	100	Meat	65	Meat	50
Peaches	200	Macaroni	120	Rice	120
Oatmeal	120	Tomatoes	100	Eggplant	100
1 egg + 1 yolk		Grape juice	200	Squash	100
Dialyzed milk		Sugar	12	Grapefruit juice	200
Sugar	35	Butter	12	Sugar	24
				Butter	12
FRIDAY					
Apple juice	200	Fish	75	Meat	50
1 egg + 1 yolk		Potatoes	100	Eggplant	100
Dialyzed milk		Tomatoes	75	Rice	120
Sugar	32	Lettuce	25	Butter	12
Coffee	as desired	Grapefruit juice	200	Sugar	39
Farina	120	Butter	12	Peaches	200
		Sugar	36		
SATURDAY					
1 egg + 1 yolk				Meat	50
Sugar	23	Meat	50	Rice	120
Cereal (oatmeal)	120	Potatoes	100	Cabbage	100
Dialyzed milk		String beans	100	Tomatoes	75
Grape juice	200	Cabbage	100	Lettuce	25
		Sugar	33	Butter	12
		Butter	12	Sugar	27
		Apples	100	Lemon juice	50
				Grapefruit juice	200
SUNDAY					
Farina	120	Lamb	50	Lean steak	50
1 egg + 1 yolk		Potatoes	100	Rice	120
Dialyzed milk		Eggplant	100	Tomatoes	75
Sugar	32	Cabbage	100	Lettuce	25
Orange (juice)	200	Butter	12	Sour cherries	100
		Lemon juice	50	Squash	100
		Fresh grapes	100	Butter	12
				Grapefruit juice	200

*Included in the diet indicated, 1,400 cc. of dialyzed milk was administered daily.

are disappointing when "low salt" diets with a 400 to 800 mg. sodium content are prescribed.

Other Studies on Sodium Restriction: Following the work of Kempner and of Grollman *et al* reviving interest in the therapeutic value of salt restriction in hypertension and kidney disease, additional investigations were reported by other workers. In 1947, Perera and Blood (19) published results of their studies with hospitalized patients at the Presbyterian and Goldwater Memorial Hospitals in New York. These studies were undertaken not only on the basis of the clinical findings reported by Kempner and Grollman, but also in view of experimental evidence with animals. Such studies had shown that the addition of sodium chloride heightens the hypertensive effect produced with the hormone, desoxycorticosterone acetate, a substance used to induce experimental hypertension in animals (20, 21).

Perera and Blood found that rigid salt restriction, following a control period to establish a baseline reference, causes a significant drop in the *"resting"* blood pressure readings. Addition of sodium chloride to the diet of such patients causes a marked rise in *"resting"* blood pressure. The potentiating effect of sodium chloride on the adrenal cortex hormone (desoxycorticosterone acetate) was also confirmed, this hormone being without sustained effect in raising blood pressure when salt was removed from the diet.

These authors point out the importance of distinguishing between *"resting"* and *"casual"* blood pressure readings. Resting pressures were those recorded every morning in bed, soon after arising and with the patient in a relaxed state. Casual readings were those taken throughout the day under varying conditions of activity. While significant responses to sodium restriction were obtained when resting readings were used, Perera and Blood reported no effect on casual blood pressure readings. They conclude:

> "The demonstration that there is an absence of correlation between *'resting'* and *'casual'* blood pressure readings suggests that the factors (at least in part neurogenic) influencing the *'casual'* readings may be independent of those influenced by sodium chloride. . . . Previous uncertainties concerning the effect of many therapeutic agents may have been due to the failure to dissociate between extrinsic (neurogenic) and direct actions on peripheral resistance,* both of which seem to be involved . . . in the clinical picture of hypertension."

They point out further, however, that there is nothing to suggest that the changes in *"resting"* blood pressure associated with rigid sodium chloride

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*Because the effect of rigid sodium chloride restriction is apparently unrelated to changes in circulatory volume, serum sodium concentration or cardiac output, the authors conclude it must be concerned with alterations in peripheral resistance, (i.e. changes in the resistance to blood flow through the capillaries. When such resistance increases, pressure is built up; when the capillaries are relaxed allowing free passage of blood, pressure is decreased).

withdrawal are of therapeutic significance or that prolonged restriction will exert any influence on the natural history of this disorder.

It is of interest to note that the diet used by Perera and Blood, although severely restricted in sodium chloride nevertheless provided from 250 to 350 mg. of sodium as compared to only 150 mg. furnished by the Kempner rice diet. Also, the protein intake of the more liberal diet provided from 70 to 80 g. of protein per day as compared with Kempner's 20 grams. These differences may have contributed appreciably to the variations in clinical findings between the two studies.

Other Studies With the Rice Diet:

The rice diet as outlined by Kempner has been investigated by a number of other workers. The findings have often been contradictory, although beneficial results in varying degrees have been reported by almost all of the investigators.

Schroeder: In a recent review, Schroeder (22) has summarized the results of various investigators, including himself, on the use of low sodium diets. As might be expected, findings were variable. A most important consideration in estimating the significance of dietary sodium, Schroeder points out, is that care be taken to provide control periods of sufficient length so that the only change is in the diet. Another vital consideration is the fact that there may be dangers from too rigid salt restriction in some individuals. In cases of "salt losing" kidney disease, for example, severe depletion of the blood in sodium and chloride or abnormal increase in blood urea may be induced with consequent uremia and death (22, 22a).

In his investigation of the rice diet, Schroeder studied six hospitalized patients who had been on control periods of at least a month. There was no change in blood pressure in three of these, a slight drop in two and a marked drop in one patient.

Flipse and Flipse: These workers studied the effect of the rice diet on a group of 32 non-hospitalized patients (23) suffering from either essential hypertension or hypertension complicated by kidney disease. Beneficial results, shown within a maximum period of six weeks, were obtained in 20 of the subjects (62.5 per cent). Of the 20 successful cases, 14 were later placed on a modified diet (meats, vegetables, small amounts of salt). Of these, 10 maintained their improvement, while four exhibited a return of increased blood pressure. Of the 12 failures, one was considered a failure because the blood pressure did not drop, but there was complete clearing

up of uremia and symptoms of nitrogen retention which actually constituted a therapeutic success. Two other patients who exhibited marked decrease in blood pressure were nevertheless also considered failures because of extreme weight loss and malnutrition. Many of the other failures were ascribed to lack of cooperation on the part of the patient in adhering to the prescribed diet.

Currens: A preliminary report of findings with a small group of patients on the rice-fruit diet was recently given by Currens (24). He found these patients to be in constant negative nitrogen balance amounting to about 4 g. of nitrogen (25 g. protein) per day during the first week. This fell off, however, after about a month to about only 0.8 g. or less. Currens found also a significant drop in plasma proteins after two to three months, but this drop never reached critically low levels even after several months on the diet. Marked drop in blood pressure was observed in occasional patients, and a slight general downward trend in many others. In a large majority of non-hospitalized patients, however, no significant changes were noted. Of 50 patients selected for dietary treatment, only 12 were able to adhere to the rigid diet. None of these exhibited a dramatic fall in pressure, but merely a general downward trend. Twenty others were found (by chloride determinations on the urine) to have surreptitiously added other foods, usually containing salt, to their diet. Others had unwittingly increased their sodium intakes by using sodium bicarbonate.* In these, the fall in blood pressure was scarcely significant.

Kempner: Several months ago, Kempner (25) published an up-to-date report on his more recent studies with the rice diet. Five hundred patients were included in this report. Most of them were seriously ill and had failed to respond to other forms of treatment. Of the 500, 178 failed to improve. The remaining 322 showed a marked decrease of arterial blood pressure (20 mm. or more), a reduction in heart size, improvement in electrocardiogram readings and disappearance of severe retinal disturbances. Actual nitrogen balances were not made, although calculations suggested the patients were maintaining nitrogen equilibrium. Signs of protein deficiency or of anemia were absent.

The diet was found to have effected changes in certain blood constituents. There was a slight decrease in non-protein nitrogen levels and in blood urea.

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*The sodium ion is believed to be of more significance than the chloride ion in causing heightened blood pressure. Determinations on urine, however, are usually made for chloride because these are easier than for sodium. Chloride determinations will reveal salt intake, but not the intake of such materials as sodium bicarbonate.

Abnormally high blood cholesterol levels dropped in most of the 70 per cent of patients who had exhibited this condition. Sodium and chloride blood levels dropped slightly, while blood potassium increased.

Significance of Low Calorie Diets:

The role of weight reduction and simple starvation has been another suggested, and bitterly disputed factor, in the control of hypertension. In general, this factor has been regarded with even less favor than sodium depletion by most authorities. Nevertheless, the recent report by Brozek, Chapman and Keys (8) on the effects of drastic food restriction seem to warrant a careful reconsideration of this aspect of the problem. These investigators review the findings of two studies, the first of which they conducted on individuals with normal blood pressure. The second study was a report of observations made on the unplanned mass starvation experiment resulting from the siege of Leningrad.

In the first study, 36 normal young men were subjected to semistarvation for six months. Various cardiovascular measurements were followed through this phase and during the subsequent period of rehabilitation. During the period of dietary restriction the daily food intake furnished 1600 calories with 49 g. of protein. The intake of sodium was not known, but it was unrestricted. There was a definite but not pronounced fall in the mean arterial blood pressures. This was paralleled by a fall in venous pressure, resting pulse rate, basal oxygen consumption and, of course, of body weight. Roentgenographically the heart size decreased.

During rehabilitation there was a gradual change in these measurements to normal. Although hypertension was not observed during rehabilitation, moderate shortness of breath and rapid heart beating on slight exertion occurred, particularly when the increase in food intake was marked. It was thought that there was a considerable strain on the cardiovascular system in these men, which was borne out by the experience of one man whose food intake during rehabilitation furnished from 7000 to 10,000 calories daily. In his case a recurrence of edema was observed after two weeks of this diet and shortness of breath on exertion was evident. The heart size was found to have increased and the venous pressure rose.

The second study covering the years during and following the famine in Leningrad was published in Russia and the results are discussed by the Minnesota authors. During the period of semistarvation, emaciation, weakness, slow heart beat, and decrease in blood pressure were observed. There

was also a reduction in the incidence of hypertension and symptoms usually related thereto. Angina pectoris and myocardial infarction or embolism likewise were reduced in incidence.

Soon after the siege of Leningrad was over and refeeding was begun, hypertension reappeared and became a major medical problem. In one study approximately 10,000 "normal" persons were examined and the percentage with elevated blood pressure (above 140 mm. systolic and 90 mm. diastolic) was compared with a similar prewar survey (1940). In the age group 30 to 39, for example, the prewar incidence of hypertension was 7 percent, while it was 30 per cent during refeeding. The increase in the age group 40 to 49 years was from 25 to 50 per cent. The increased incidence was thought not to be due to changes in the age and sex distribution of the population. Concomitantly, there was approximately five times increase over prewar in the hospital admissions for hypertensive disease, which had dropped markedly during the famine. In June, 1943, 60 per cent of all hospital admissions were for hypertensive disease. Symptoms such as headache, vertigo, and fainting became much more prominent than before the war, as were retinal hemorrhages and exudate. The increased incidence of congestive heart failure in hypertensive patients also was alarming, while renal damage not only did not increase but probably actually decreased in incidence.

Unfortunately, no knowledge of the salt intake was available for Leningrad, although the authors thought it to be low but not as meager as required by Kempner.

There is no doubt from these various studies that restricting the diet produces dramatic changes in cardiovascular function. Equally startling are the reverse changes with epidemic hypertensive disease following refeeding as observed in Leningrad. As indicated in a recent editorial (26), these studies emphasize the fact that the role of food in the pathogenesis and therapy of hypertensive disease deserves careful investigation.

Mechanism of Sodium Restriction:

Whether sodium depletion is effective in reducing blood pressure is still an open question. The findings of various clinical investigators have been widely divergent. This is undoubtedly due to marked differences in the diets used, particularly with respect to sodium content, as well as to lack of adequate control periods and similar factors for establishing uniformity of experimental conditions. Another extremely important consideration is that many so-called "low-sodium" diets contain far more than the desirable maximum of 200 mg. of sodium (18a) and are thus doomed to failure.

Despite considerable doubt on the part of many authorities, much of the evidence in favor of sodium depletion can not be ignored. If some insight into the reason for the action of sodium depletion could be obtained, the entire status of the rice diet and of other low sodium diets might be considerably clarified.

A partial explanation was suggested by Perera and Blood (19) and has since been extended somewhat by Stead and associates (27). According to the latter, there are at least three factors involved in the maintenance of blood pressure: The basic tone of the blood vessels, the influence of chemical substances in the blood (humora component), and the effect of nerve impulses on the contractility of the blood vessels (neurogenic component). Perera and Blood (19) advanced the hypothesis that sodium deprivation diminished the effect of the basal humoral component of the blood pressure, but that this decrease in pressure was counteracted or off-set by an increase in neurogenic tone encountered throughout the normal activities of the day.

Stead *et al* attempted to confirm and extend this hypothesis through the use of the drug tetraethylammonium chloride (TEAC). TEAC has been shown by many investigators to block certain autonomic nerve impulses. Ferris, Stead and coworkers (28) believe that the fall in blood pressure due to TEAC represents the removal of the neurogenic component. Consequently the only remaining variable in the blood pressure behavior following TEAC administration must reflect the part played by non-neurogenic factors, i.e. all the humoral agents or chemical factors (the tone of the vascular bed being more or less a constant factor).

Using this hypothesis, they studied the effect of sodium depletion on twelve hypertensive patients to whom TEAC had been administered in order to eliminate the neurogenic factor in blood pressure maintenance. Any further decrease in blood pressure obtained following the "floor level" induced by TEAC could thus be ascribed directly to sodium depletion.

They found in five patients that salt depletion induced a significant lowering of the TEAC floor. The decrease was offset to an appreciable extent, however, by neurogenic factors as soon as the effect of the TEAC wore off. This was confirmed by an increase in the normal TEAC response during periods of salt depletion. There was little or no change in blood sodium concentrations at any time in these patients. In the remaining seven patients salt depletion caused a significant drop in blood sodium levels which was associated with no fall in random blood pressure and no change in the normal response to TEAC. The authors concluded, "in general the results suggest:

"(1) That in some patients with essential hypertension and only moderately

impaired renal function, the important change during sodium deprivation may be a lessening of the humoral contribution to the maintenance of an increased peripheral resistance.

"(2) That in other patients with malignant hypertension, renal failure, or both, an apparently large humoral component in peripheral resistance may be uninfluenced by an even greater degree of sodium depletion."

Mechanism of Rice Diet:

The efficacy of the rice diet has not as yet been traced conclusively to any one factor in its makeup. It may be the low salt content, it may be caloric restriction, it may be low fat or low protein, it may be the low cholesterol, it may conceivably even be some unknown characteristic of the rice, or it may be a combination of several or all of these factors.

Kempner (29, 25) has suggested that the diet may be effective because it somehow permits compensation of metabolic dysfunction of the kidney in nephritis and hypertension. Kempner points out that the kidney functions in two ways: (1) as an excretory organ and (2) as a specialized tissue engaged in specialized metabolic activities. Interference with proper oxygen supply, in *in vitro* experiments, causes inhibition of vital biochemical activities of the kidney (decreased ability to deaminate amino acids, to form ammonia, to oxidize ketoacids, etc.). What practical significance have these experimental physiological findings with kidney tissue slices in the treatment of diseases in which renal metabolic dysfunction may play a role? Kempner cites some simple examples to illustrate the possible rationale involved:

"Let us assume that the oxygen *supply* to any one kidney cell has been decreased by some pathological condition and that we are unable to increase it; still it might be possible to increase the oxygen *concentration* by reducing the amount of work required from this cell, thus decreasing its oxygen demand. Or let us assume that the rate of oxidation of ketoacids in any one diseased kidney cell is decreased; still it might be possible to reduce the amount of ketoacids offered to the cell if we were able to remove from the diet those substances from which ketoacids are derived. . . . It would be desirable, of course, to substitute for the natural ferments that have been destroyed, extracts of animal kidneys . . . or synthetic substances with the same chemical properties as those in normal kidney cells. Unfortunately, such substances are not yet available. . . . A less perfect approach, but one which has led to rather satisfactory results, is the compensation of renal metabolic dysfunction with the rice diet."

Kempner has pointed out the distinctions between normal fasting persons and hypertensive patients on the rice diet. He maintains that on the rice diet protein nitrogen loss is less, urea nitrogen excretion is less and blood urea nitrogen is below normal (as compared to above normal levels in fasting).

Similarly, while hemoglobin and plasma protein levels decrease in starvation, they are maintained on the rice diet. Thus, the effect of the rice diet cannot be compared to simple starvation or protein depletion.

The importance of fat restriction in the rice diet is shown by the reduction in the abnormally high blood cholesterol levels which are a common part of the picture in hypertensive diseases, especially in relation to the development of retinal disturbances, heart diseases and arteriosclerosis.

The importance of rigid salt restriction has been demonstrated by numerous experimental and clinical studies, although the evidence is still not sufficiently clear-cut to be convincing to all workers in this field.

Although the mode of action of the rice diet is still largely unexplained and, as Kempner pointed out some years ago, "no matter which single factor in the rice diet is of greatest importance in compensating the various manifestations of renal dysfunction, it remains true that in 203 of 322 patients on most of whom other forms of therapy had previously been tried, the rice diet led to objective improvement." He concluded further:

> "I am sometimes told that enlarged hearts in hypertensive vascular disease become smaller 'spontaneously', that electrocardiograms became normal 'spontaneously', and that papilledema, hemorrhages and exudates in the retina disappear 'spontaneously'. I have not been fortunate enough to see many of these 'spontaneous' recoveries, but I have often seen blindness as a result of advancing retinopathy, and death from heart failure, myocardial infarction, renal insufficiency, or cerebral vascular accident in patients who were not willing to submit to any drastic form of treatment because they believed that their disease would clear up spontaneously or that at least it would not become worse."

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